

7.1 Day-of-Week Patterns of Heavy-Duty and Non-Heavy-Duty Vehicle Activity At Weigh-in-Motion Stations Relevant to the South Coast Air Basin During the Summer of 1997

Lawrence C. Larsen

7.1.1 Abstract

In this section, we analyze day-of-week differences in the activity of heavy-duty vehicles (trucks) and non-heavy-duty vehicles. Heavy-duty trucks are particularly important because they produce a disproportionately large fraction of NO_x emissions in the South Coast Air Basin. Therefore, differences in heavy-duty truck activity by day-of-week may be an important contributor to differences in air pollution on weekdays compared to weekends.

The Weigh-in-Motion (WIM) network, maintained by CALTRANS, counts vehicles and simultaneously identifies their weight classes. Daily vehicle counts (24-hour totals) from WIM stations in and around the South Coast Air Basin demonstrate that the volume of heavy-duty trucks is much lower on weekends compared to weekdays in all locations. The data also show that the daily volume of non-heavy-duty vehicles decreases on weekends at some locations but increases at others.

In the central urbanized area, the volumes of both heavy-duty and non-heavy-duty vehicles are lower on weekends compared to their mid-week volumes. In addition, the decrease in heavy-duty traffic is greater than the decrease in non-heavy-duty traffic.

In the peripheral non-urbanized area, the volume of heavy-duty vehicles decreases on weekends while the volume of non-heavy-duty vehicles is similar for all days of the week. At these sites, the reduction in heavy-duty traffic is not as great as the reduction at the more centrally located sites.

Hourly data for heavy-duty and non-heavy-duty traffic by day-of-week are highly desirable and may become available in the near future; such data would help clarify the degree to which changes in heavy-duty traffic patterns support the various hypotheses.

Nevertheless, the WIM data are consistent with Hypothesis #1, Hypothesis #2, and Hypothesis #3a. The lack of hourly information precludes a more detailed assessment. The WIM data do not support Hypothesis #4, because increases in weekend traffic appear to be limited to peripheral sites and are not characteristic of the metropolitan areas of the South Coast Air Basin. Even so, the WIM data do not address other emission sources that may increase on weekends.

7.1.2 Methodology

In this section, we discuss the data, locations, and methods used to examine differences in heavy-duty and non-heavy-duty traffic on weekdays versus weekends and to present the results.

7.1.2.1 Data

Data from the network of WIM stations were provided to us by Dr. Niemeir at U.C.-Davis. These data were collected during the summer of 1997 by CALTRANS and examined by Dr. Niemeir as part of the overall SCOS97-NARSTO field study. The data set contained daily vehicle counts for each of 14 vehicle classes at each WIM site during the summer of 1997. Table 7.1.1 shows the class definitions that were supplied with the data.

Although hourly data would be most useful, such data have not yet been obtained from CALTRANS. Nevertheless, the daily data reveal potentially important differences in the traffic volumes by vehicle class and by day-of-week.

We did not conduct general QA/QC procedures beyond those applied by CALTRANS and/or Dr. Niemeir. However, three sites were not considered beyond summarizing the data. The Fontana site (No. 69) was not considered because only southbound traffic was monitored. The Newhall site (No. 6) was not considered because only northbound traffic was monitored and because the data were highly variable and may not be valid. The Murrieta site was not considered because the heavy-duty data are extremely variable and may not be valid; unlike any other site, these data varied by more than 100% for observations on the same day of the week.

7.1.2.2 Locations

Several WIM stations are paired with another station on opposite sides of a freeway. Each pair of stations provides counts for east and westbound or north and southbound traffic; for example, station No. 8 and station No. 9 cover southbound and northbound traffic respectively on the Ventura Freeway at milepost 37.8. Table 7.1.2 lists the WIM stations and their locations. For paired stations, the counts were combined to form a single value. For unpaired stations that have no designated direction, we assumed the counts included the traffic in both directions.

7.1.2.3 Methods of Analysis and Presentation

Our analysis of the WIM data is straightforward. We summed the counts for classes 8-14 to represent the number of heavy-duty vehicles. Similarly, the sum of the counts for classes 1-7 represents the number of non-heavy-duty vehicles.

We report results both in original units and relative to mid-week, Tuesday through Thursday, levels. Complete results are presented for all sites in Table 7.1.3. Two graphs, one in original units and one in relative units are provided for each WIM site.

7.1.3 Results and Discussion

7.1.3.1 General results

Some observations apply to the activity data at all or almost all stations considered for further analysis.

Heavy-duty activity drops dramatically at all sites compared to mid-week levels. On Saturday, heavy-duty activity averaged 45% of mid-week levels, ranging from 31% (Elsinore and Long Beach) to 61% (Indio and Van Nuys). On Sunday, heavy-duty activity averaged 33% of mid-week levels, ranging from 17% (Peralta) to 59% (Indio).

Non-heavy-duty activity decreased less than heavy-duty activity on weekends at all sites and even increased at some sites. On Saturday, non-heavy-duty activity averaged 94% of mid-week levels, ranging from 76% (Montrose) to 148% (Castaic). On Sunday, non-heavy-duty activity averaged 84% of mid-week levels, ranging from 62% (Montrose) to 184% (Indio).

In the basin as a whole, the volumes of both heavy-duty and non-heavy-duty vehicles are lower on weekends compared to their mid-week volumes. However, the decrease in heavy-duty traffic is greater than the decrease in non-heavy-duty traffic. Therefore, the ratio of heavy-duty to non-heavy-duty vehicles is substantially lower on weekends compared to weekdays. The estimated ratios are 1:20 on weekdays, 1:50 on Saturday, and 1:100 on Sunday.

Among weekdays, Friday had the highest volume of non-heavy-duty traffic at all sites but one (Montrose). The increase averages 7% across all sites.

The ratio of heavy-duty to non-heavy-duty vehicles is substantially lower on weekends compared to weekdays. The WIM data are in close agreement with the VMT estimates in recent emission inventory models. Preliminary estimates of the ratio based on these two sources, are 5% on weekdays, 2% on Saturday, and 1% on Sunday.

Table 7.1.4 shows that activity patterns in the central (more urbanized) areas appear to differ systematically from the activity patterns in the peripheral (less urbanized) areas. The central sites were Long Beach, Ventura Freeway, Van Nuys, Irvine, Peralta, and Montrose, while the peripheral sites were Redlands, Castaic, Elsinore, Indio, and Devore.

7.1.3.1.1 Heavy-duty activity

In aggregate, the heavy-duty activity on weekends decreased more at the central sites compared to the peripheral sites. When the central sites are combined, their total volume relative to mid-week levels was 39% on Saturday and 22% on Sunday. When the peripheral sites are combined, their total volume relative to mid-week levels was 53% on Saturday and 44% on Sunday.

The day-of-week effects for heavy-duty traffic were not uniform, however, for all sites within the central or within the peripheral category. Relative to mid-week levels, the central sites ranged from 31% to 62% on Saturday and 17% to 38% on Sunday. In comparison, the peripheral sites ranged from 31% to 106% on Saturday and 18% to 97% on Sunday.

7.1.3.1.2 Non-heavy-duty activity

Except at Peralta, the central, more urbanized locations show the activity of non-heavy-duty vehicles decreasing on weekends. The Peralta site is close to Disneyland, which may explain why non-heavy-duty traffic at Peralta was higher on Saturday (104%) compared to mid-week levels.

In aggregate, the non-heavy-duty activity on weekends decreased at the central sites and increased at the peripheral sites. When the central sites are combined, their total volume relative to mid-week levels was 91% on Saturday and 78% on Sunday. When the peripheral sites are combined, their total volume relative to mid-week levels was 102% on Saturday and 100% on Sunday.

Relative to mid-week levels, the central sites (except Peralta) ranged from 76% to 93% on Saturday and from 62% to 79% on Sunday. In comparison, the peripheral sites ranged from 84% to 148% on Saturday and from 73% to 184% on Sunday.

Increases in weekend traffic at peripheral sites may be due to multiple factors. For instance, non-heavy-duty traffic may increase on routes that serve recreational or entertainment facilities, such as lakes, casinos, resorts, and amusement parks. Long-distance travel for recreation or visitation may also cause increases in weekend traffic on major entry and exit routes. How significant such increases are is not clear, however, since they tend to be increases in small volumes relative to the large volumes at central sites.

7.1.4 Conclusions

The WIM data lack hourly resolution and are limited, therefore, in their ability to distinguish between alternative causes of the weekend effect. Nevertheless, these data do help set the stage on which other datasets can address the various hypotheses. From the WIM data alone, we draw several preliminary conclusions.

First, the volume of heavy-duty trucks throughout the South Coast Air Basin is lower on weekends compared to weekdays.

Second, the volume of non-heavy-duty vehicles decreases on weekends in the central, metropolitan areas of the Basin but increases in the peripheral, non-metropolitan areas.

Third, in the basin as a whole, the volumes of both heavy-duty and non-heavy-duty vehicles are lower on weekends compared to their mid-week volumes. However, the decrease in heavy-duty traffic is greater than the decrease in non-

heavy-duty traffic. Therefore, the ratio of heavy-duty to non-heavy-duty vehicles is substantially lower on weekends compared to weekdays. The estimated ratios are 1:20 on weekdays, 1:50 on Saturday, and 1:100 on Sunday.

Among weekdays, Friday had the highest volume of non-heavy-duty traffic at all sites but one (Montrose). The increase relative to the mid-week volume averages 7% across all sites.

Hourly data for heavy-duty and non-heavy-duty traffic by day-of-week may become available in the near future; such data would help clarify the degree to which changes in heavy-duty traffic patterns support the alternative hypotheses.

Nevertheless, the WIM data are consistent with Hypothesis #1, Hypothesis #2, and Hypothesis #3a. The lack of hourly information precludes a more detailed assessment. The WIM data are somewhat inconsistent with Hypothesis #4, because any increase in weekend traffic appears to be limited to peripheral sites rather than the metropolitan areas of the South Coast Air Basin. Even so, the WIM data do not address other emission sources that may increase on weekends.

7.1.5 Recommendations

Three recommendations for future work emerge from our analyses.

First, hourly summaries for the WIM data should be acquired and analyzed. The day-of-week differences in several parameters, such as VOC/NO_x ratios, would be more clearly understood by using hourly values rather than daily values for the WIM data.

Second, WIM data for extended periods should be acquired and analyzed. In our analyses, only a few days were available in some cases to characterize the volumes of heavy-duty and non-heavy-duty vehicles for a particular day-of-week. Results would be more reliable and convincing if based on data that are more extensive.

Third, data for activity on surface streets are needed. Such data should identify the classes of vehicles as well as counting the total vehicles. In addition, such data should be assembled on an hourly basis. The full picture of on-road activity would then be more complete.

7.1.6 References

Table 7.1.1 Standard criteria used to classify vehicles at Weigh-in-Motion Stations*

Class	Vehicle Description	Axles	Weight (kips)	
			min	max
0	unclassifiable			
1	motorcycle	2	0.10	3.00
2	auto, pickup	2	1.00	7.99
2	auto w/ 1 axle trailer	3	1.00	11.99
2	auto w/ 2 axle trailer	4	1.00	11.99
3	other (limo, van, RV)	2	1.00	7.99
3	other w/ 1 axle trailer	3	1.00	11.99
3	other w/ 2 axle trailer	4	1.00	11.99
3	other w/ 3 axle trailer	5	1.00	11.99
4	bus	2	12.00	N/A
4	bus	3	20.00	N/A
5	2D	2	8.00	N/A
6	3 axle	3	12.00	N/A
7	4 axle	4	12.00	N/A
8	2S1, 21	3	12.00	N/A
8	3S1, 31	4	12.00	N/A
8	2S2	4	12.00	N/A
9	3S2	5	12.00	N/A
10	3S3, 33	6	12.00	N/A
11	2S12	5	12.00	N/A
12	3S12	6	12.00	N/A
13	2S23, 3S22, 3S13	7	12.00	N/A
13	3S23	8	12.00	N/A
13	permit	9	12.00	N/A
14	32	5	12.00	N/A
15	unclassifiable or errc	0		

* Differentiation between classes also depends on spacing between axles. Note: one "kip" equals one thousand pounds.

Table 7.1.2. Weigh-in-Motion stations selected for analysis due to their proximity to the South Coast Air Basin.

Station No.	Name	Nearby A.Q. Monitor	County	Fwy/Mile Post
5	INDIO	(none)	RIV	10-R59.4
6	NEWHALL (NB only)	SANTA CLARITA	LA	5-44.6
8, 9	VENTURA FWY	RESEDA	LA	101-37.8
12, 13	VAN NUYS	RESEDA	LA	405-42.9
15, 16	IRVINE	IRVINE	ORA	5-25.8
37, 38	ELSINORE	LAKE ELSINORE	RIV	15-21.6
39	REDLANDS	REDLANDS	SBD	30-31.7
47, 48	CASTAIC	SANTA CLARITA	LA	5-R56.1
59, 60	LONG BEACH	N. LONG BEACH	LA	710-11.5
61, 62	PERALTA	ANAHEIM	ORA	91-R11.9
63	MURRIETA	(none)	RIV	215-R5.0
67	DEVORE	CRESTLINE	SBD	215-14.8
69	FONTANA (SB only)	FONTANA	SBD	15-6.1
101, 102	MONTROSE	BURBANK	LA	2-7.5

Table 7.1.3 Heavy-Duty and Non-Heavy-Duty Traffic at WIM Stations in and Near the SCAB

WIM Station Name	No.	Day of Week	Average Daily Total			Percent of Tue. - Thu. Activity			% of Daily Total	
			Duty Classification		Total	Duty Classification		Total	Duty Classification	
			Heavy	Non-Heavy		Heavy	Non-Heavy		Heavy	Non-Heavy
Long Beach	59 and 60	1	3866	112800	116666	20%	67%	62%	3.3%	96.7%
		2	17785	161715	179500	94%	96%	96%	9.9%	90.1%
		3	19126	167965	187091	101%	100%	100%	10.2%	89.8%
		4	18920	166526	185446	100%	99%	99%	10.2%	89.8%
		5	18948	170204	189152	100%	101%	101%	10.0%	90.0%
		6	19180	178343	197524	101%	106%	105%	9.7%	90.3%
		7	5951	138023	143975	31%	82%	77%	4.1%	95.9%
Ventura Fwy	8 and 9	1	1266	135200	136466	31%	80%	79%	0.9%	99.1%
		2	3303	146207	149510	80%	87%	86%	2.2%	97.8%
		3	4181	166272	170453	102%	99%	99%	2.5%	97.5%
		4	4020	168682	172702	98%	100%	100%	2.3%	97.7%
		5	4121	171421	175542	100%	102%	102%	2.3%	97.7%
		6	4235	180659	184893	103%	107%	107%	2.3%	97.7%
		7	2072	151584	153656	50%	90%	89%	1.3%	98.7%
Van Nuys	12 and 13	1	1329	169739	171068	37%	80%	79%	0.8%	99.2%
		2	3470	215010	218480	98%	102%	102%	1.6%	98.4%
		3	3615	215362	218977	102%	102%	102%	1.7%	98.3%
		4	3615	218130	221745	102%	103%	103%	1.6%	98.4%
		5	3407	201561	204967	96%	95%	95%	1.7%	98.3%
		6	3663	227082	230745	103%	107%	107%	1.6%	98.4%
		7	2180	197044	199224	61%	93%	93%	1.1%	98.9%
Irvine	15 and 16	1	1457	168785	170242	19%	76%	74%	0.9%	99.1%
		2	7484	216631	224115	96%	97%	97%	3.3%	96.7%
		3	7804	219885	227688	101%	99%	99%	3.4%	96.6%
		4	7581	222855	230436	98%	100%	100%	3.3%	96.7%
		5	7885	225709	233594	102%	101%	101%	3.4%	96.6%
		6	7700	234174	241874	99%	105%	105%	3.2%	96.8%
		7	3120	198649	201768	40%	89%	88%	1.5%	98.5%

WIM Station Name	No.	Day of Week	Average Daily Total			Percent of Tue. - Thu. Activity			% of Daily Total	
			Duty Classification		Total	Duty Classification		Total	Duty Classification	
			Heavy	Non-Heavy		Heavy	Non-Heavy		Heavy	Non-Heavy
Fontana (southbound only)	69	1	2811	58059	60870	55%	115%	109%	4.6%	95.4%
		2	5817	51978	57795	113%	103%	104%	10.1%	89.9%
		3	4960	49613	54573	97%	98%	98%	9.1%	90.9%
		4	4996	50403	55399	97%	100%	99%	9.0%	91.0%
		5	5427	51809	57236	106%	102%	103%	9.5%	90.5%
		6	5058	57842	62900	99%	114%	113%	8.0%	92.0%
		7	2336	52000	54336	46%	103%	97%	4.3%	95.7%
Redlands	39	1	298	40561	40859	29%	73%	72%	0.7%	99.3%
		2	985	53828	54813	97%	97%	97%	1.8%	98.2%
		3	1079	55452	56531	107%	100%	100%	1.9%	98.1%
		4	1018	54986	56004	101%	99%	99%	1.8%	98.2%
		5	940	55926	56866	93%	101%	101%	1.7%	98.3%
		6	784	56243	57027	77%	101%	101%	1.4%	98.6%
		7	425	46589	47014	42%	84%	83%	0.9%	99.1%
Newhall (northbound only)	6	1	2544	11481	14025	35%	106%	77%	18.1%	81.9%
		2	9577	14768	24345	131%	136%	134%	39.3%	60.7%
		3	8709	13256	21965	119%	122%	121%	39.7%	60.3%
		4	7669	11431	19100	105%	105%	105%	40.2%	59.8%
		5	5570	7831	13401	76%	72%	74%	41.6%	58.4%
		6	5195	9834	15029	71%	91%	83%	34.6%	65.4%
		7	3725	15313	19037	51%	141%	105%	19.6%	80.4%
Castaic	47 and 48	1	5344	80105	85449	38%	148%	125%	6.3%	93.7%
		2	13253	58645	71898	93%	108%	105%	18.4%	81.6%
		3	14039	51803	65841	99%	96%	96%	21.3%	78.7%
		4	14191	52637	66828	100%	97%	98%	21.2%	78.8%
		5	14368	57747	72115	101%	107%	106%	19.9%	80.1%
		6	13276	76931	90207	93%	142%	132%	14.7%	85.3%
		7	6804	72516	79320	48%	134%	116%	8.6%	91.4%

WIM Station Name	No.	Day of Week	Average Daily Total			Percent of Tue. - Thu. Activity			% of Daily Total	
			Duty Classification		Total	Duty Classification		Total	Duty Classification	
			Heavy	Non-Heavy		Heavy	Non-Heavy		Heavy	Non-Heavy
Elsinore	37 and 38	1	746	66096	66842	18%	96%	92%	1.1%	98.9%
		2	4046	68161	72206	99%	99%	99%	5.6%	94.4%
		3	4092	67365	71457	100%	98%	98%	5.7%	94.3%
		4	3994	67074	71069	98%	98%	98%	5.6%	94.4%
		5	4172	71575	75746	102%	104%	104%	5.5%	94.5%
		6	3424	73291	76716	84%	107%	105%	4.5%	95.5%
		7	1276	71106	72382	31%	104%	99%	1.8%	98.2%
Indio	5	1	3571	14688	18259	59%	184%	130%	19.6%	80.4%
		2	5146	9238	14384	85%	116%	102%	35.8%	64.2%
		3	5376	6588	11964	88%	83%	85%	44.9%	55.1%
		4	6372	8212	14584	105%	103%	104%	43.7%	56.3%
		5	6519	9116	15635	107%	114%	111%	41.7%	58.3%
		6	5281	13007	18288	87%	163%	130%	28.9%	71.1%
		7	3728	11767	15496	61%	148%	110%	24.1%	75.9%
Peralta	61 and 62	1	1461	192633	194094	17%	94%	91%	0.8%	99.2%
		2	8485	198176	206661	99%	97%	97%	4.1%	95.9%
		3	8685	201391	210076	102%	99%	99%	4.1%	95.9%
		4	8493	205203	213696	99%	100%	100%	4.0%	96.0%
		5	8444	206398	214842	99%	101%	101%	3.9%	96.1%
		6	8237	214319	222556	96%	105%	105%	3.7%	96.3%
		7	3336	211806	215142	39%	104%	101%	1.6%	98.4%
Montrose	101 and 102	1	65	59918	59983	22%	62%	62%	0.1%	99.9%
		2	266	94377	94643	91%	98%	98%	0.3%	99.7%
		3	303	91628	91930	103%	95%	95%	0.3%	99.7%
		4	277	99961	100238	95%	104%	104%	0.3%	99.7%
		5	299	98040	98339	102%	102%	102%	0.3%	99.7%
		6	323	93865	94188	110%	97%	97%	0.3%	99.7%
		7	135	73833	73967	46%	76%	76%	0.2%	99.8%

WIM Station		Day of Week	Average Daily Total			Percent of Tue. - Thu. Activity			% of Daily Total	
Name	No.		Duty Classification		Total	Duty Classification		Total	Duty Classification	
			Heavy	Non-Heavy		Heavy	Non-Heavy		Heavy	Non-Heavy
Murrieta	63	1	2158	33860	36018	97%	80%	80%	6.0%	94.0%
		2	2891	38527	41418	130%	91%	93%	7.0%	93.0%
		3	2840	42419	45259	128%	100%	101%	6.3%	93.7%
		4	1965	41677	43643	88%	98%	98%	4.5%	95.5%
		5	1864	43502	45366	84%	102%	101%	4.1%	95.9%
		6	2976	42248	45223	134%	99%	101%	6.6%	93.4%
		7	2361	37116	39477	106%	87%	88%	6.0%	94.0%
Devore	67	1	934	33604	34538	41%	86%	83%	2.7%	97.3%
		2	2111	39101	41212	92%	100%	99%	5.1%	94.9%
		3	2325	38778	41103	101%	99%	99%	5.7%	94.3%
		4	2222	38986	41208	97%	99%	99%	5.4%	94.6%
		5	2331	39987	42318	102%	102%	102%	5.5%	94.5%
		6	2124	43705	45829	93%	111%	110%	4.6%	95.4%
		7	1127	34563	35690	49%	88%	86%	3.2%	96.8%

**Table 7.1.4 Summary of heavy-duty
and non-heavy-duty traffic at central
and peripheral WIM sites**

Day of Week	All Sites	Central Sites	Peripheral Sites
Total Volume of Heavy-Duty Trucks			
1	27849	9443	13050
2	84617	40792	28432
3	87131	43712	29750
4	85333	42905	29762
5	84293	43103	30193
6	81455	43337	27865
7	38574	16793	15721
Heavy-Duty Trucks as % of Midweek			
1	32.5%	21.8%	43.6%
2	98.9%	94.3%	95.1%
3	101.8%	101.1%	99.5%
4	99.7%	99.2%	99.5%
5	98.5%	99.7%	101.0%
6	95.2%	100.2%	93.2%
7	45.1%	38.8%	52.6%
Total Volume of Non-Heavy-Duty Vehicles			
1	1177528	839074	268914
2	1366362	1032116	267499
3	1387777	1062503	262406
4	1406764	1081358	263572
5	1410825	1073333	277852
6	1501543	1128442	305425
7	1311908	970939	273657
Non-Heavy-Duty Vehicles as % of Midweek			
1	84.0%	78.2%	100.4%
2	97.5%	96.2%	99.8%
3	99.0%	99.1%	97.9%
4	100.4%	100.8%	98.4%
5	100.6%	100.1%	103.7%
6	107.1%	105.2%	114.0%
7	93.6%	90.5%	102.1%

Figure 7.1.1 Indio (WIMS No. 5): Total Volume

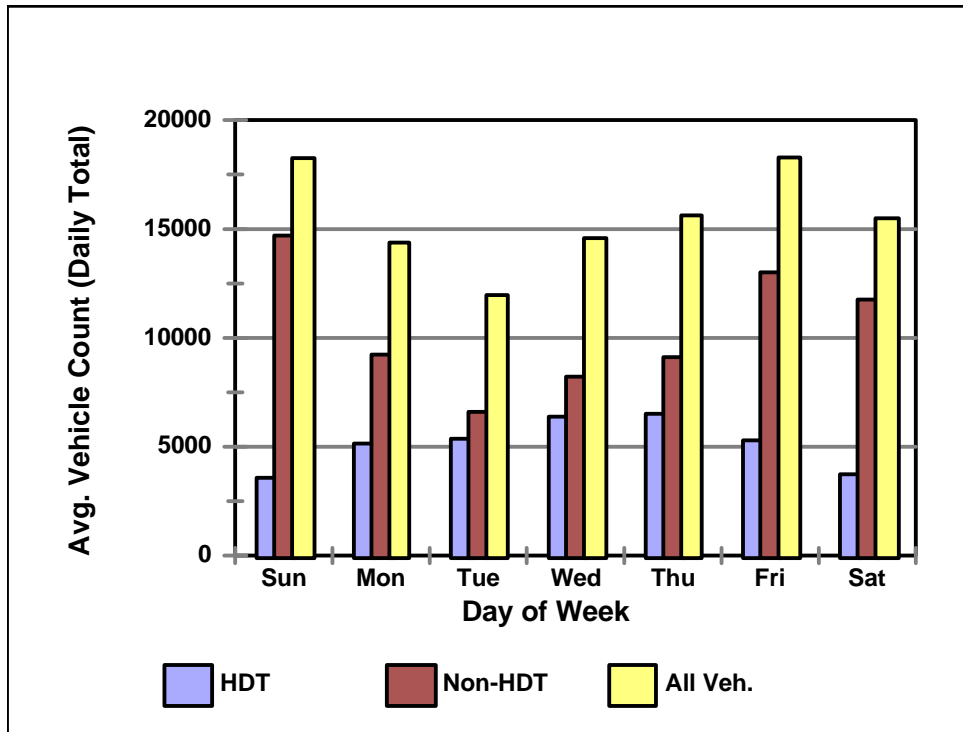


Figure 7.1.2 Indio (WIMS No. 5): Relative Volume

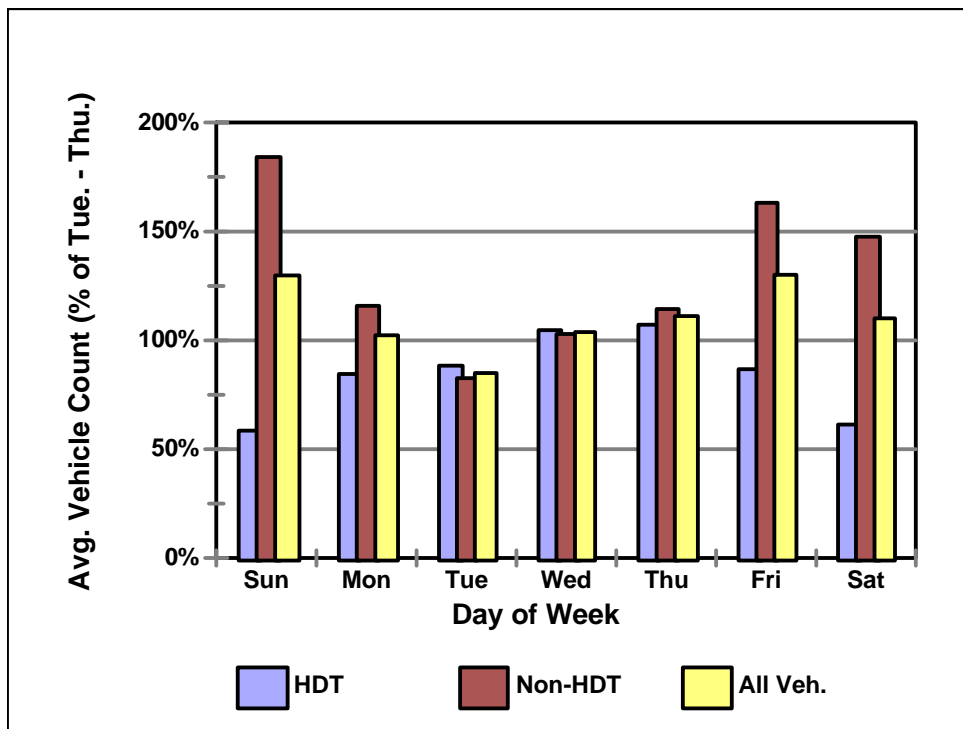


Figure 7.1.3 Ventura Fwy (WIMS Nos. 8/9): Total Volume

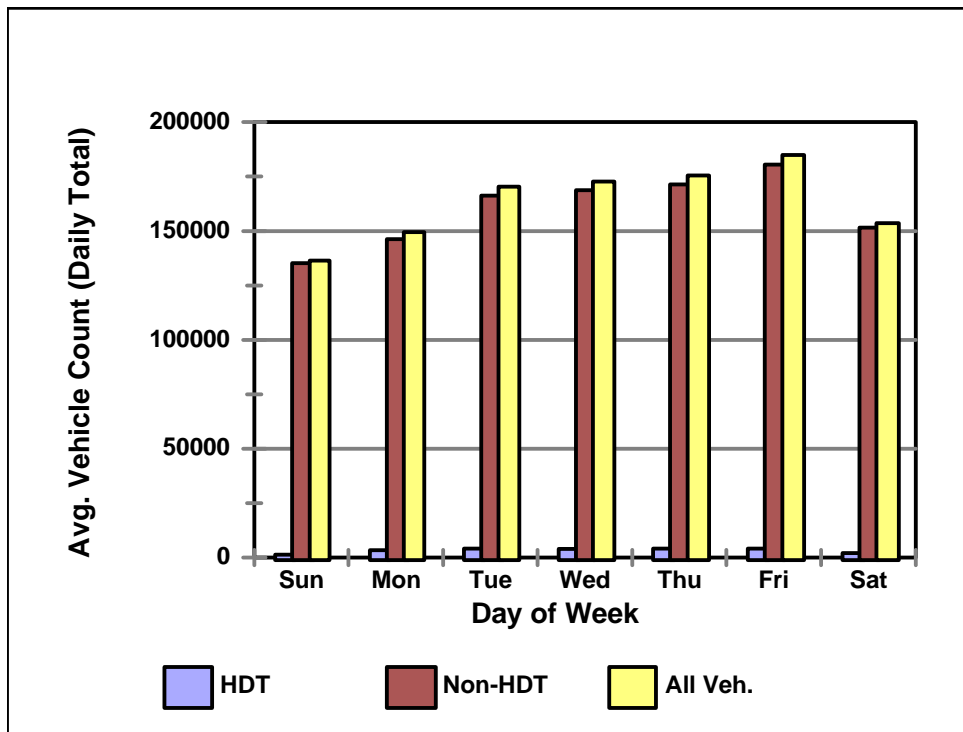


Figure 7.1.4 Ventura Fwy (WIMS Nos. 8/9): Relative Volume

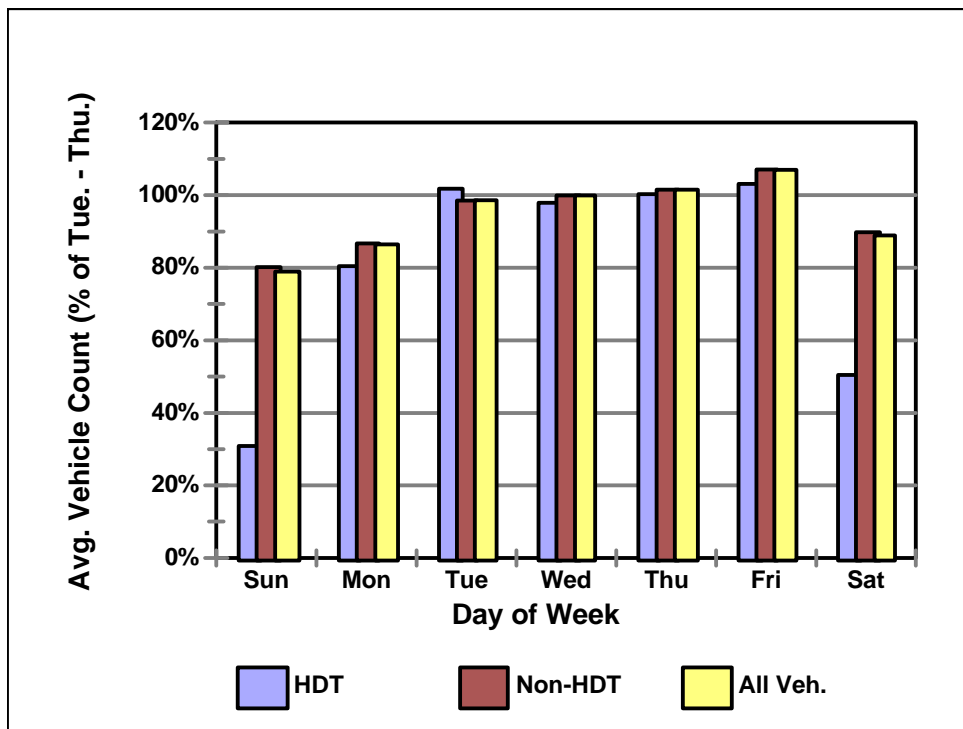


Figure 7.1.5 Van Nuys (WIMS Nos. 12/13): Total Volume

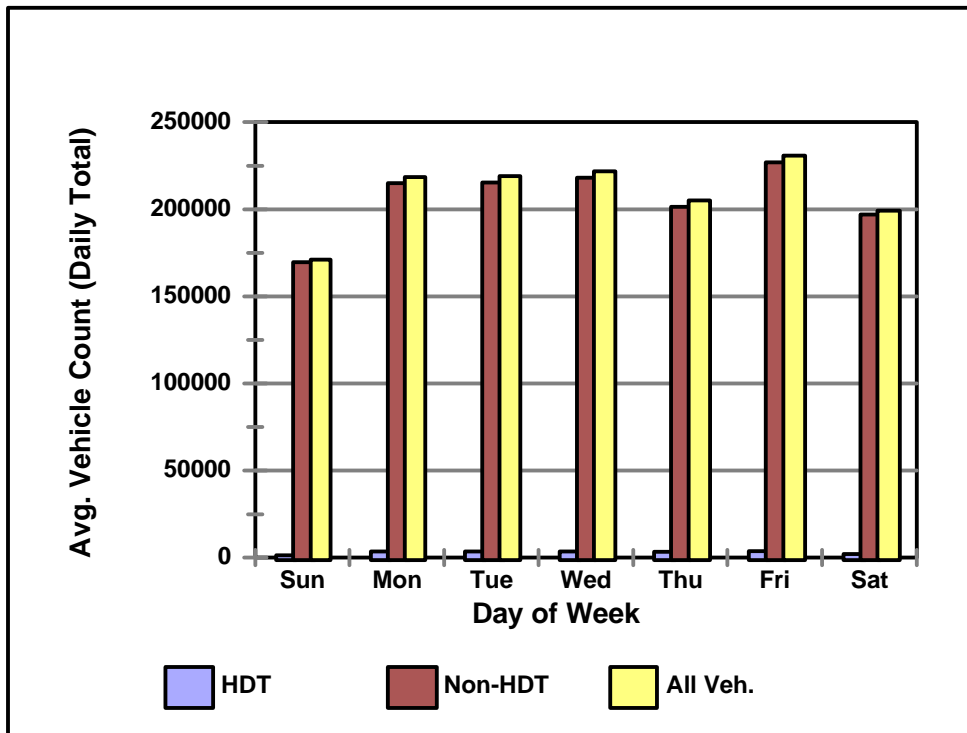


Figure 7.1.6 Van Nuys (WIMS Nos. 12/13): Relative Volume

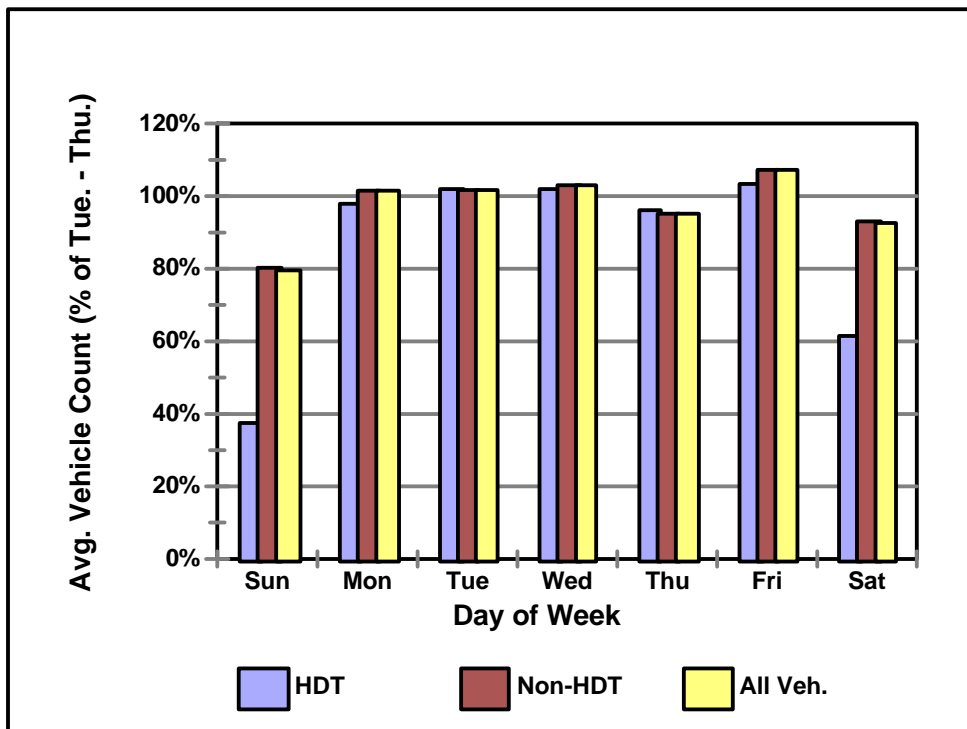


Figure 7.1.7 Irvine (WIMS Nos. 15/16): Total Volume

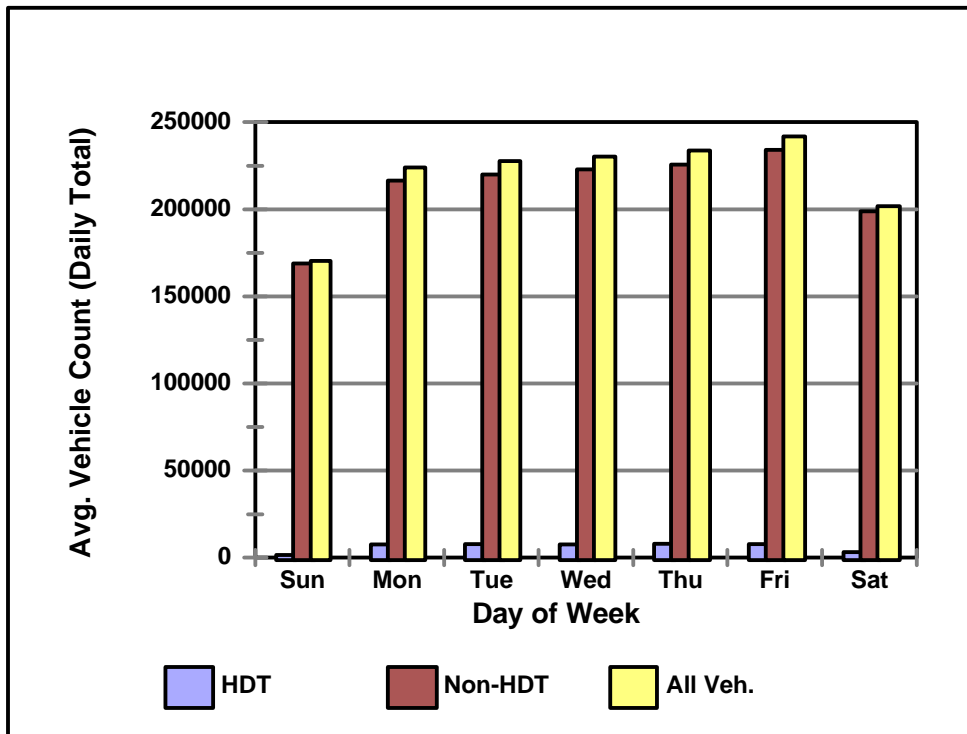


Figure 7.1.8 Irvine (WIMS Nos. 15/16): Relative Volume

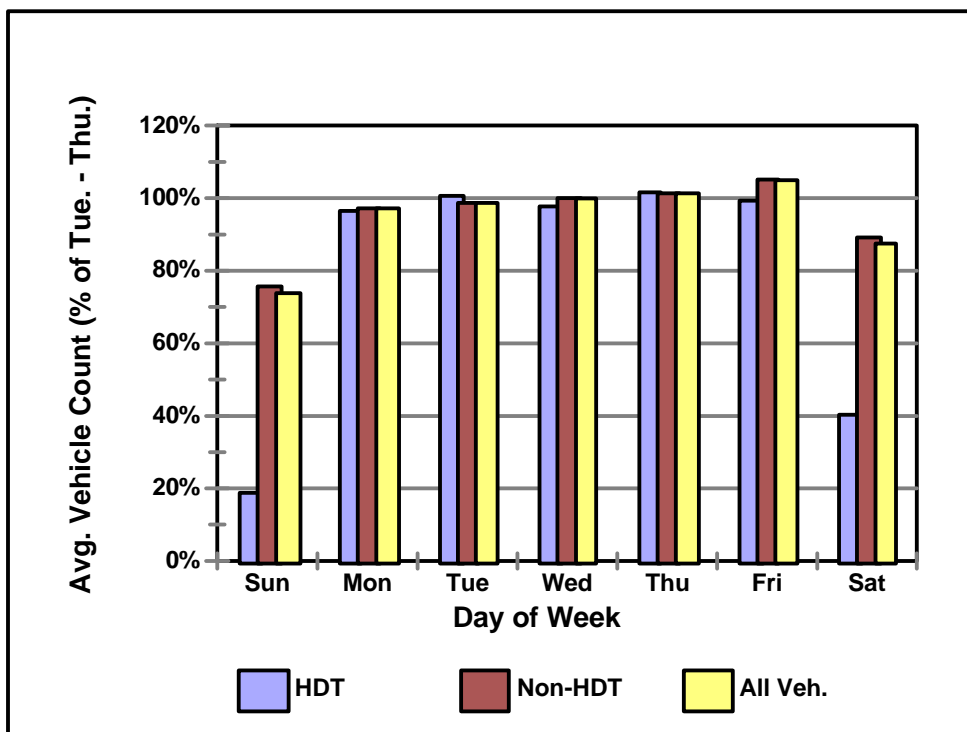


Figure 7.1.9 Elsinore (WIMS Nos. 37/38): Total Volume

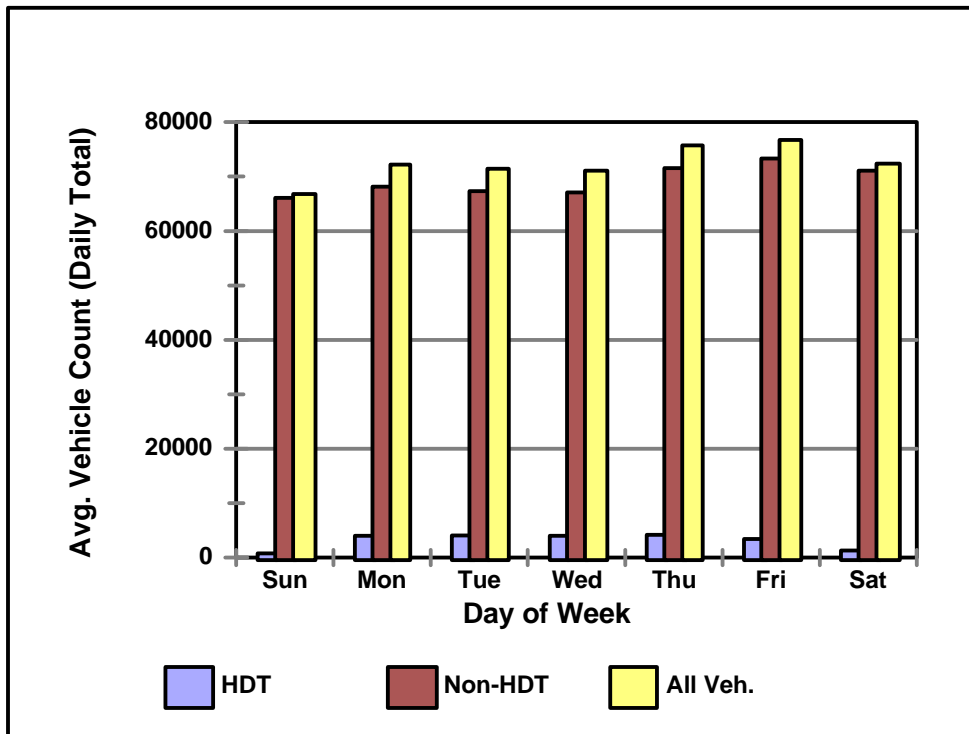


Figure 7.1.10 Elsinore (WIMS Nos. 37/38): Relative Volume

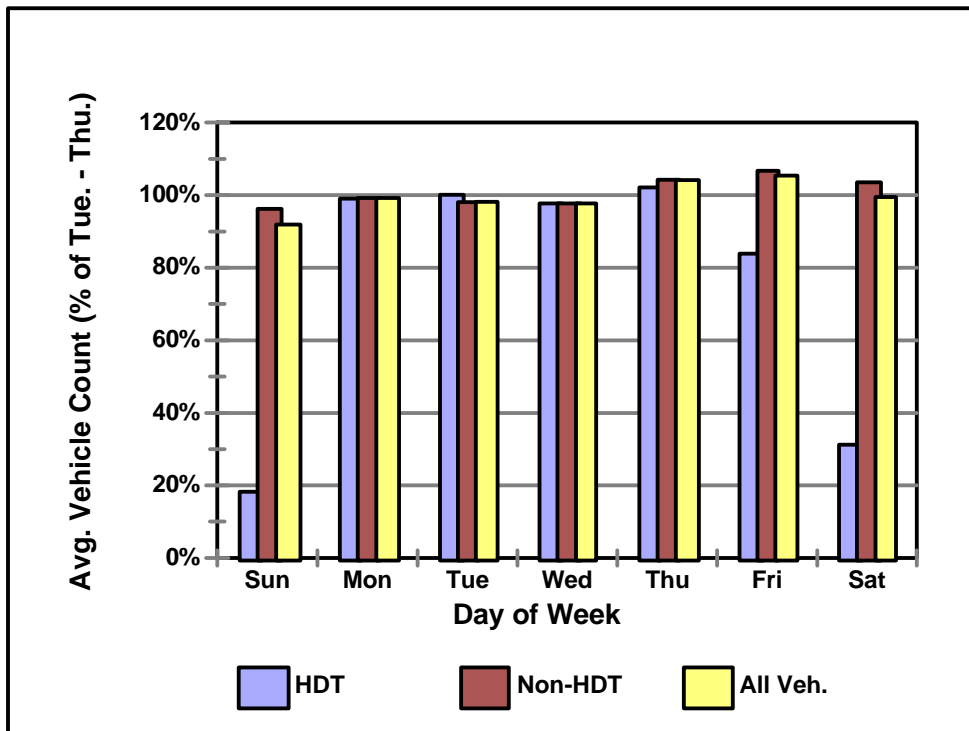


Figure 7.1.11 Redlands (WIMS No. 39): Total Volume

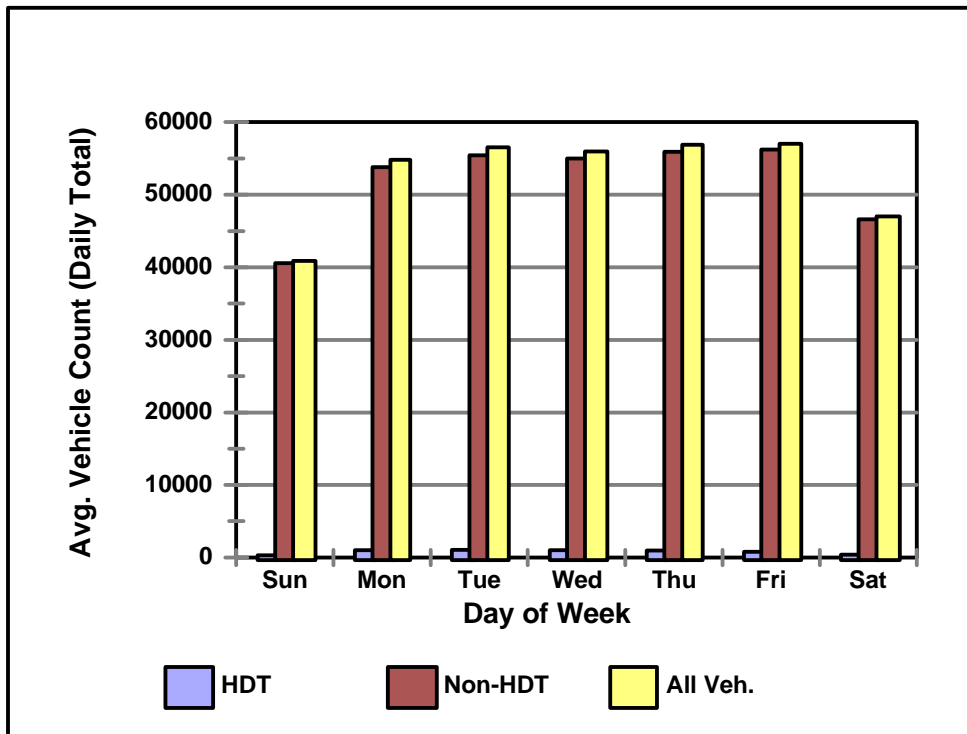


Figure 7.1.12 Redlands (WIMS No. 39): Relative Volume

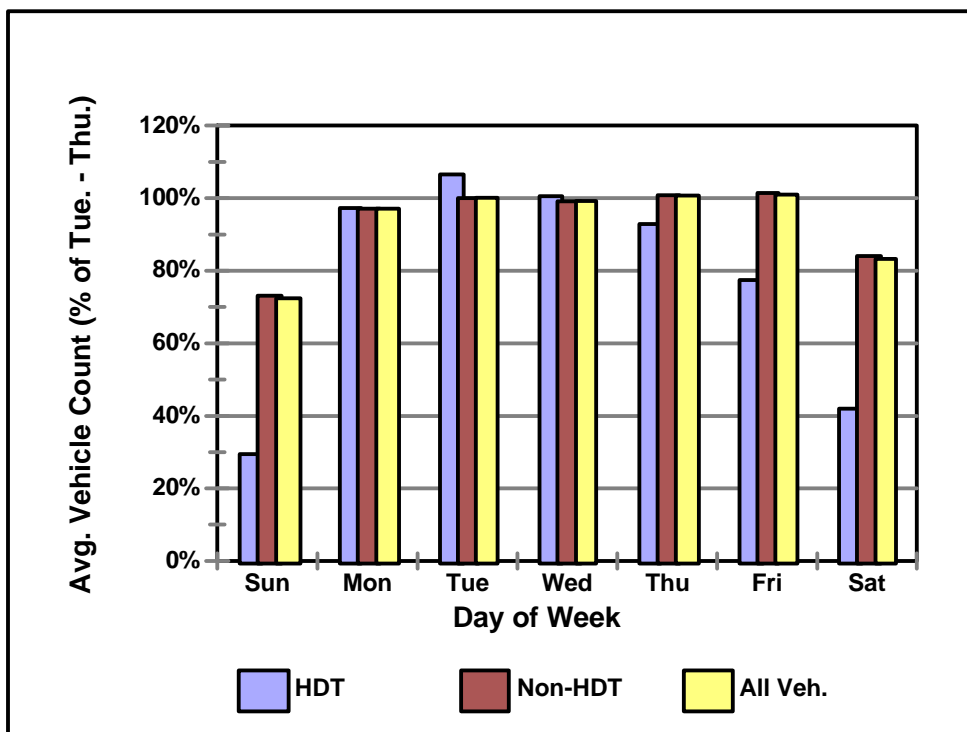


Figure 7.1.13 Castaic (WIMS Nos. 47/48): Total Volume

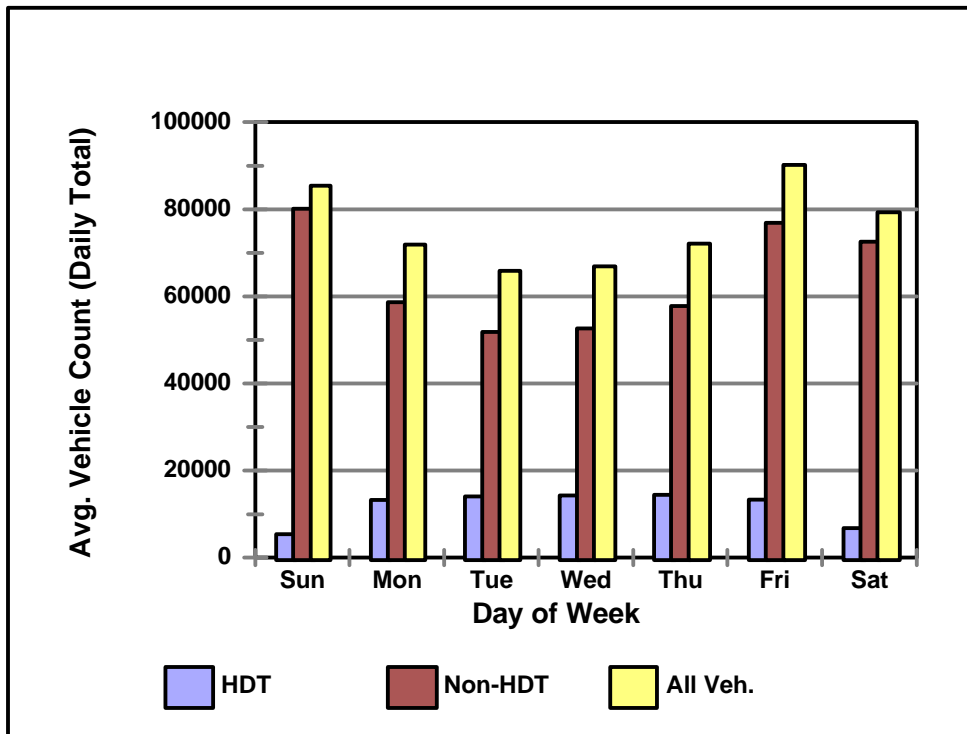


Figure 7.1.14 Castaic (WIMS Nos. 47/48): Relative Volume

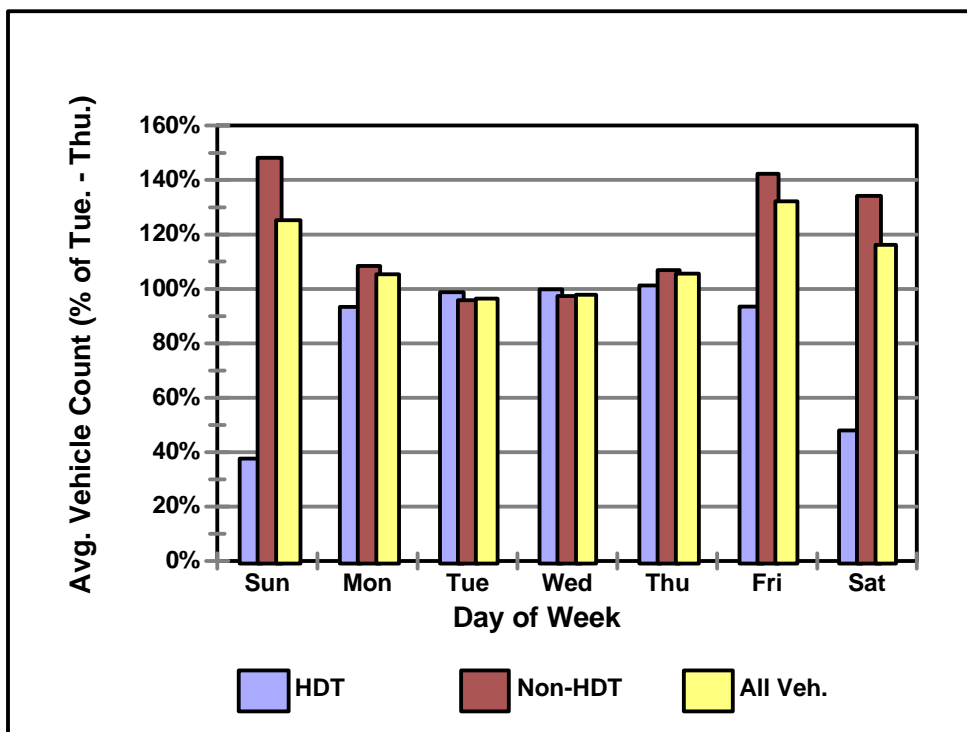


Figure 7.1.15 Long Beach (WIMS Nos. 59/60): Total Volume

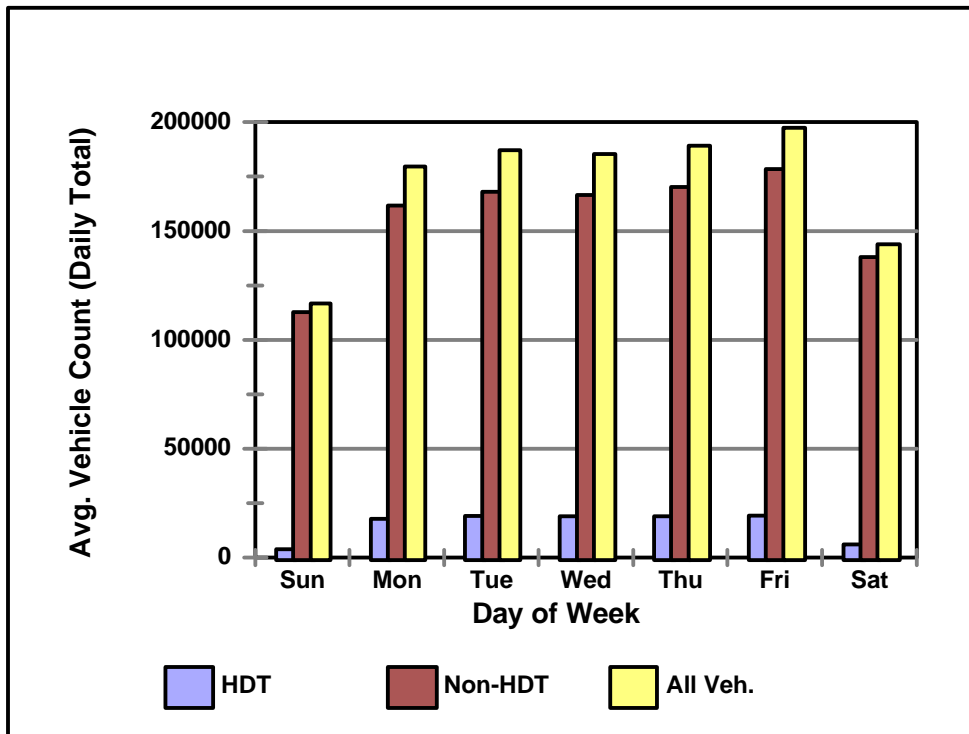


Figure 7.1.16 Long Beach (WIMS Nos. 59/60): Relative Volume

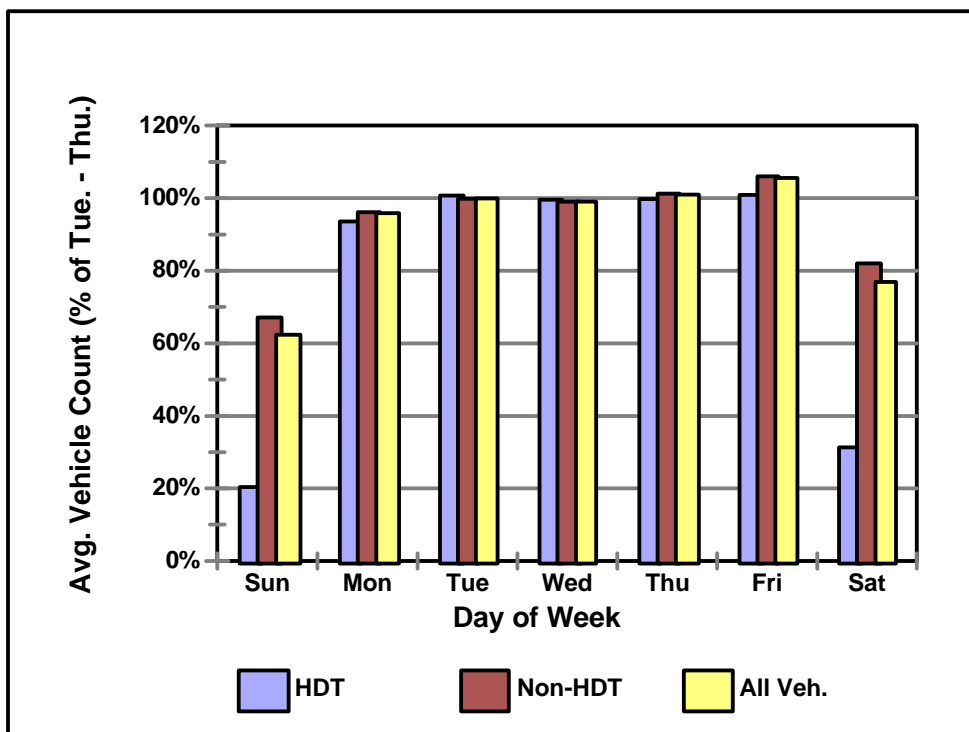


Figure 7.1.17 Peralta (WIMS Nos. 61/62): Total Volume

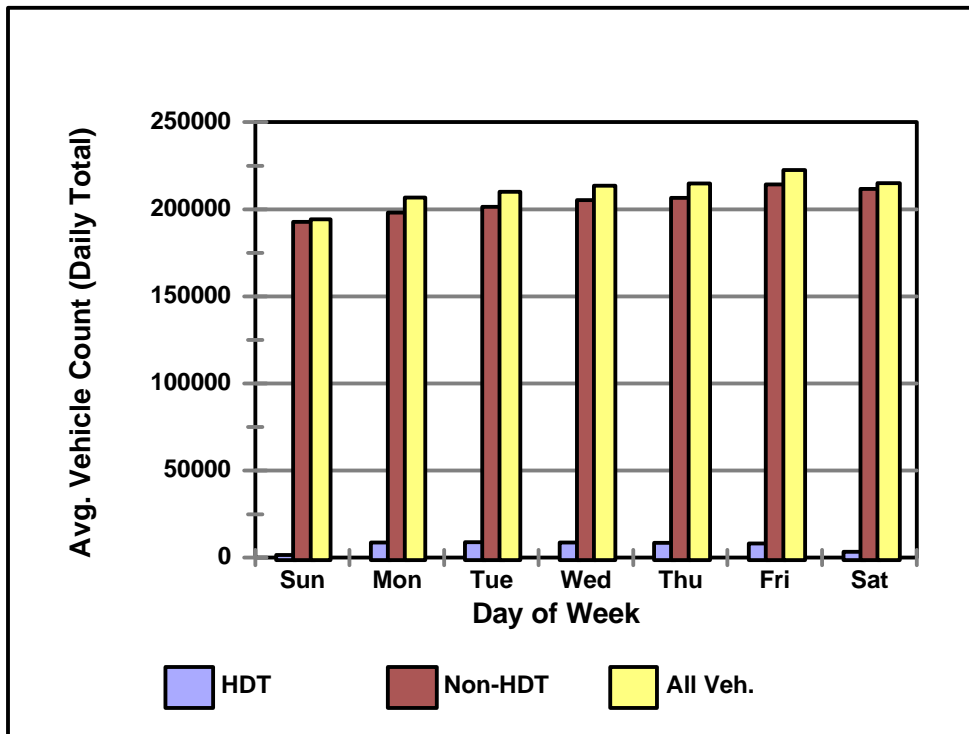


Figure 7.1.18 Peralta (WIMS Nos. 61/62): Relative Volume

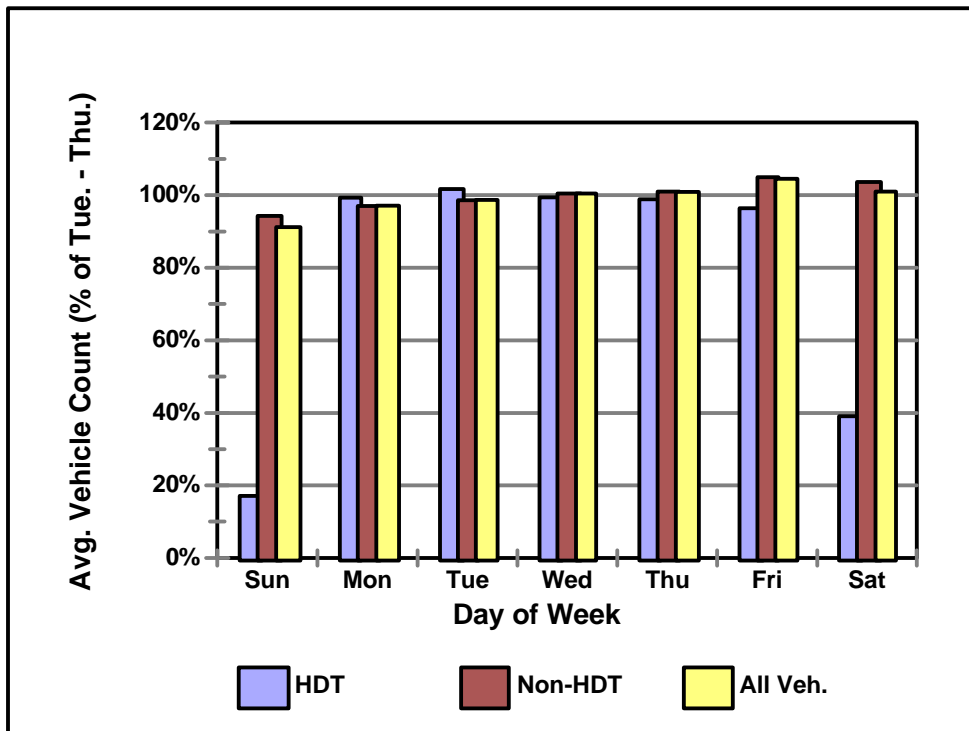


Figure 7.1.19 Murrieta (WIMS No. 63): Total Volume

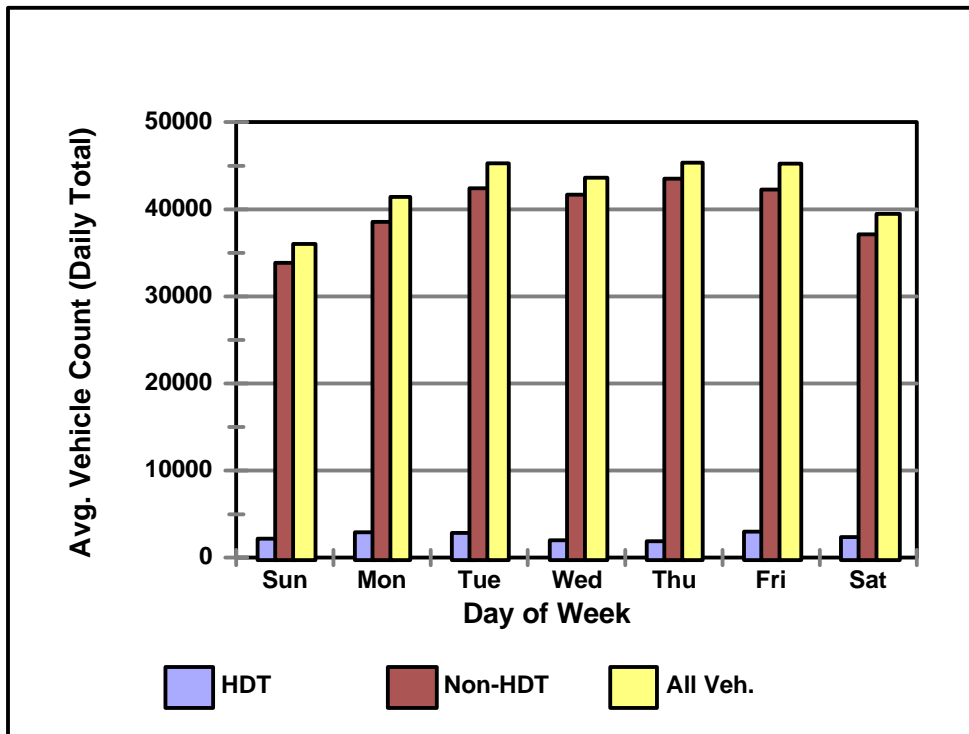


Figure 7.1.20 Murrieta (WIMS No. 63): Relative Volume

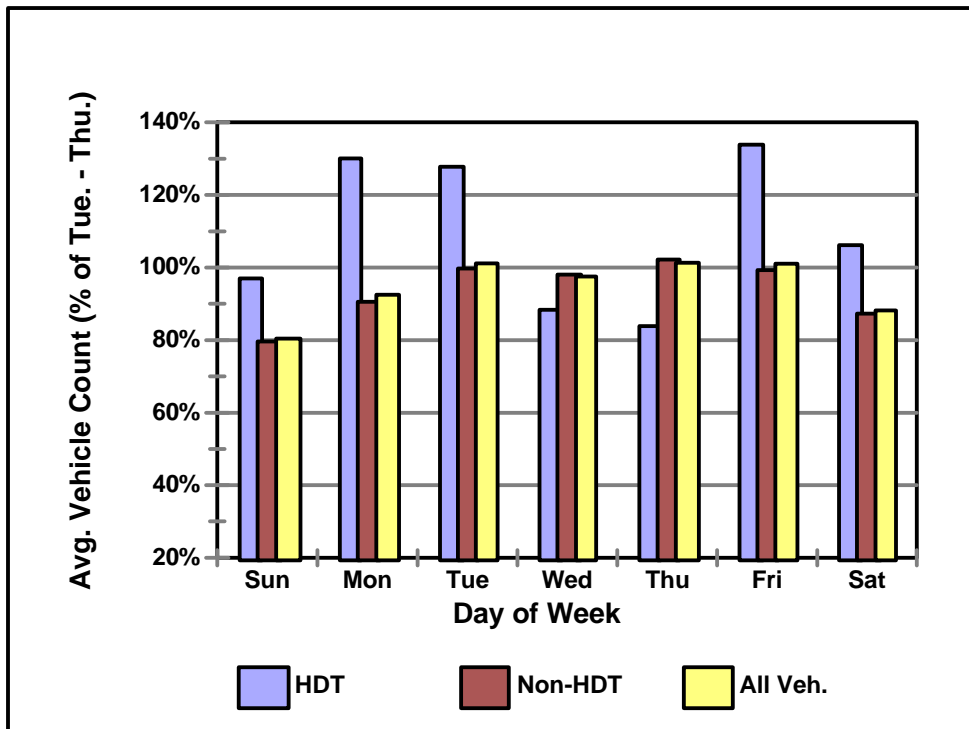


Figure 7.1.21 Devore (WIMS No. 67): Total Volume

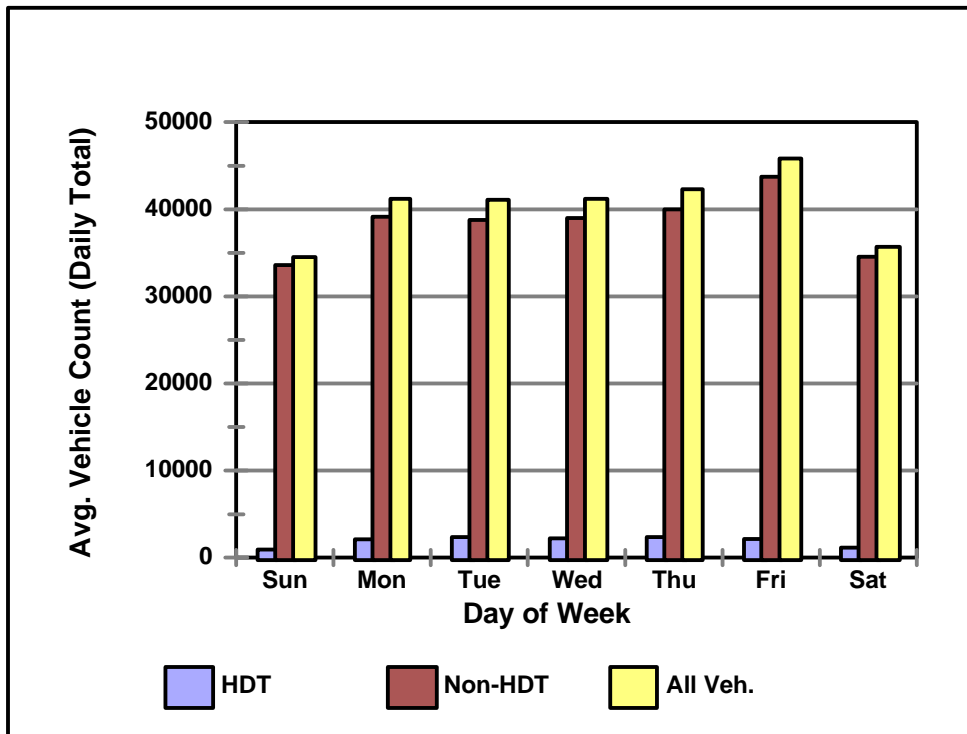


Figure 7.1.22 Devore (WIMS No. 67): Relative Volume

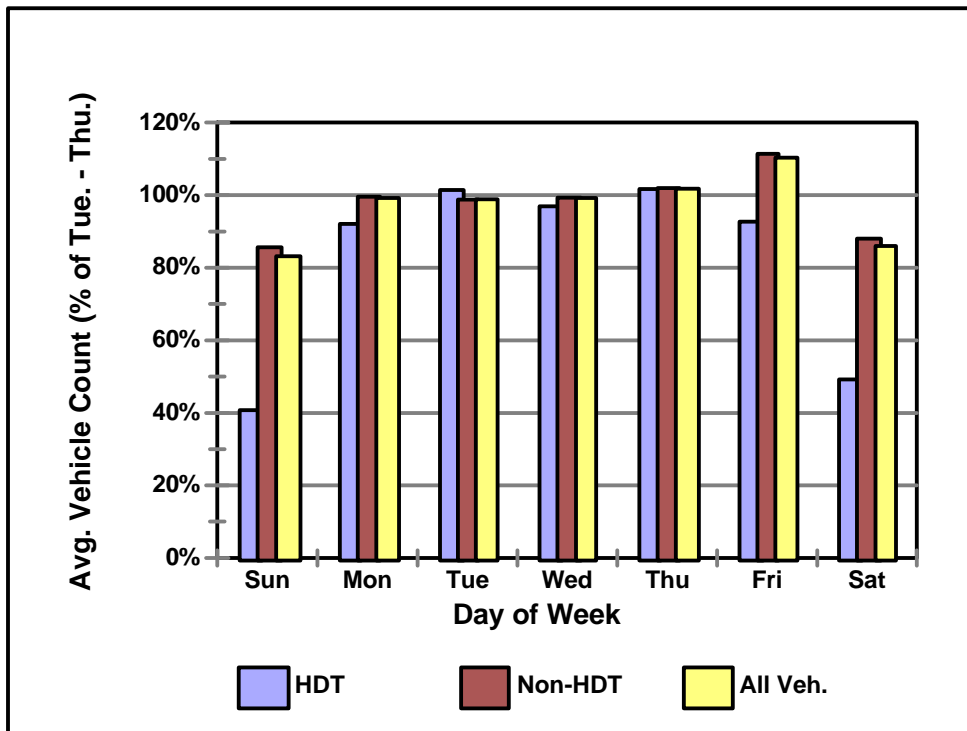


Figure 7.1.23 Montrose (WIMS Nos. 101/102): Total Volume

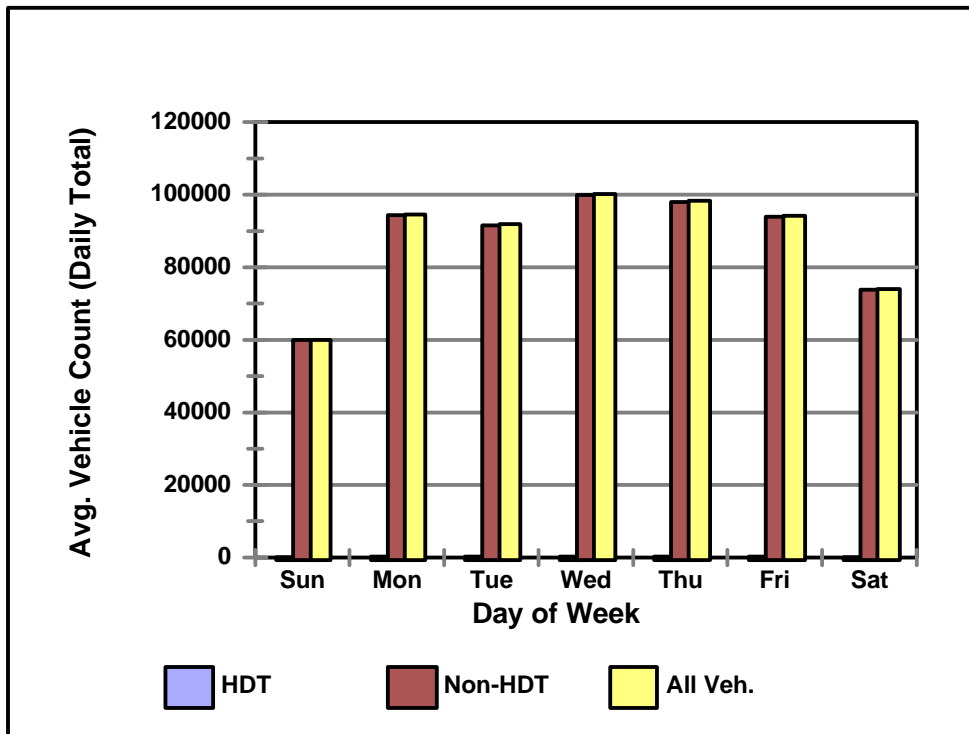


Figure 7.1.24 Montrose (WIMS Nos. 101/102): Relative Volume

